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Information processing and the challenges facing lean healthcare

Tony Kinder and Trelawney Burgoyne

Abstract

Radnor and Walley (2008) and others have identified a high failure rate in NHS lean rapid improvement events. This paper explores one reason why these failures occur: from the perspective of information processing (Galbraith 1974), it explores the difficulties facing lean healthcare projects. Using qualitative method (pre-understanding and interviews) with analysis triangulating between data, general theory and sense-making we investigate two lean projects currently running at a Scottish hospital to identity how the absence of adequate information affects the projects. We find that the projects are critically hampered by the absence of project-level, inter-unit level and organisational level information. The practical implications of our research are to suggest that before embarking upon lean projects, hospital leaderships should explore the adequacy and integratedness of their information systems, decision-taking structures and inter-unit coordination mechanisms.

Key words: healthcare, lean, information processing

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Biographies

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1 INTRODUCTION

For the NHS, in the *age of austerity*, the mantra of *more from less* is increasingly found in a generalised rollout of lean projects. Yet perhaps as many as 50% lean projects fail to deliver sustained savings. This paper argues that lean projects require levels of information beyond the capability of many NHS organisations and that Galbraith's (1974) information processing theory helps explain why and how many NHS lean healthcare projects fail. If our conclusion is generalisable, it challenges the premise that the NHS can deliver sustainable cost reductions, whilst at the same time improving quality of care, by using lean tools.

At a micro-level the failure of lean and other change projects in the NHS may be explained by situation factors such as absence of clinician support or a rejection of the 'cuts' ideology (Radnor and Walley 2008): ungeneralisable subjective factors. Macro-level frameworks, (such as Neely 2007), whilst powerful, insufficiently capture change processes. Our aim is to understand how the complexity and uncertainty characterising healthcare affect the *processes* of using of lean tools, looking through the lens of information processing guided by Simon's (1974) insight that performance in any type of organisation limits the organisation's ability to process information. In effect we are synthesising lean thinking as developed by Womack and Jones (2003) with Tushman and Nadler's (1978) information-processing framework; both of which seek to eliminate or reduce complexity by concentrating on information flows.

The genesis of our argument is Lapsley's (2009) paper arguing that some of the proponents of new public management techniques fail to grasp the *complexity* of public services, leading to the imposition of strategies making public services *less* adaptive to a changing environment. As Perrow (1979) and Anderson (1999) point out, high control and coordination are most difficult where complexity and uncertainty are the norm. UK healthcare is noted for complexity and uncertainty at both organisational and task levels (Dawson and Dargie 1999, Kollberg *et al* 2005) including environmental uncertainty, infinite demand, complex patient diagnostics and care pathways, and high levels of tacit knowledge. Picking up Lapsley's (2009) point, we will argue that in general terms the complexity of many NHS services, inadequacy of its lateral and vertical information systems and functional structure doom many lean projects to failure.

We address two research questions. Firstly, how effectively do lean healthcare projects, (characterised by high instability, uncertainty and complexity), manage information processing and secondly, do the challenges of reintegrating lean project information with information systems contribute to project failure?

Section two reviews literature on lean in healthcare and information processing. Following an outline of method (section three), we present data from original interviews and casework in two Scottish health boards, which we then analyse.

2 LITERATURE

We show how lean thinking has developed into an important approach to the management of change in healthcare and then explores the application of information

processing theory to organising and projects arguing that since lean seeks evidence from facts – its success depends upon information availability.

2.1 Lean healthcare services

Womack, Jones and Roos (1990:225) conclude their classic lean study saying,

> *Lean production is a superior way for humans to make things. It provides better products in wider variety at lower cost. ... It follows that the whole world should adopt lean production, and as quickly as possible.*

Sixteen-years later the NHS Institute for Innovation and Improvement announced that lean thinking is the favoured tool for NHS improvement (NHSII 2011). Womack and Jones' (1996) five lean principles are: (a) *value* is defined from the customer's perspective; (b) holistic service systems are constituted from clear *process* steps; (c) systemic process *flow* drives effectiveness; (d) customer *pull* drives efficiency; and (e) *continually removing waste* sustains leanness. Lean privileges flow above *batch and queue* (Ohno (1988) and drives *continuous improvement* (Bhasin and Burcher 2006).

Numerous authors comment on the *dark-side* of leanness from Kamata's (1984) on intensity of work critique to Cusumano and Nobeoka's (1998) argument that platform technologies and team working have overtaken lean as the driver of continuous improvement.

Lean in services
Levitt's (1976) suggestion that lean thinking applies to services stimulated a burgeoning research (see Swank 2003). Services are wasteful, George's (2003) study of Stanford hospital concludes, because demand can be variable and work-in-progress hidden in queues of unanswered emails, calls and follow-ups. Yet professional personal services face contradictory pressures: market demands for personalisation and diversity; whilst efficiency privileges standardisation and simplification. Lean services automate actions and limit staff discretion using standard operation procedures (SOPs) (Hines *et al* 2004): controversial measures in healthcare. As Goldratt (1993) points out, improving flow means continually seeking and eliminating *bottlenecks*. Typically, bottlenecks stifle throughput and increase both inventory and operating costs: an hour lost at a bottleneck is an hour lost to the system.

Lean seeks knowledge flows from customers and suppliers and iterates between intra- and inter-organisational relations (Kinder 2003). Intra-organisationally, lean services are characterised by clear value flows, low inventory, teamworking, active problem-solving and commitment-based human relations (Bowen and Youngdahl 1998). Inter-organisational lean service organisations enjoy tight information flows, knowledge exchange and shared destiny.

Lean in healthcare
Examples applying lean techniques in UK healthcare include NHS-Direct (McKenna and Reynolds 1999), telemedicine (Kinder *et al* 1999) and e-Prescribing (Schade *et al* 2006). George's (2003) study of Stanford hospital's lean healthcare emphasises cross-departmental teams, integrated clinical data, patient journeys and benchmarking.

Walley (2007) explores system re-engineering and demand smoothing, illustrating how co-location of specialists and demand management can improve A&E performance. Spear's (2005) study emphasises that flow is preferable to *batch-and-queue* and is best achieved by organising around patient flow rather than functions. Radnor *et al's* (2006:1) study of lean practices in the Scottish public sector concludes that *within the public sector, however, there is engagement with the principles of Lean, but less with the full range of tools and techniques.* They find that most lean initiatives are *rapid improvement events* rather than long-term whole system applications and that over half involve less than 20% of staff; however, they do not explore project processes and why they fail. We fill this gap by showing how NHS information systems are incapable of supporting rapid improvement events (RIEs) in particular and lean initiatives in general.

Implementing lean in healthcare
Implementing lean healthcare gives rise to numerous issues including creating islands of lean (Young *et al* 2004). Ballé and Régnier (2007) suggest that the three years needed for a lean project to succeed is too long a period for services with vulnerable people and changing leadership (NHS CEOs current average 17 months). HR difficulties can be considerable and opportunities for experimentation rare (Proudlove *et al* 2007). Caldwell *et al* (2005) suggest that only 50% of time saved in lean exercises is crystallised into money saved. Lodge and Bamford's (2008) study of patient database integration in an English NHS Trust emphasises that without staff training and support lean exercises fail. The wider the lean footprint, as Papadopoulos and Merali (2008) argue, the longer the implementation time to build new networking arrangements. Information processing in lean health care is an under-researched issue, noting Fillingham's (2007) argument that only system-wide lean initiatives, including information systems, can succeed. Radnor and Walley (2008), however, argue that whole system approaches to lean including rapid improvement events are both valid; a conclusion disputed in this paper. We argue that whilst *localised* factors may jeopardise the success of lean NHS initiatives, especially absence of staff support (especially clinical professionals); the generalised absence of effective information systems in NHS organisations challenge Radnor and Walley's conclusions on the validity of using lean approaches in the NHS, since lean projects require real-time and robust information (time/costs).

Information flows are critical to lean projects not only to reduce uncertainty and ambiguity, flows of information encourage learning (Csikszentmihaly 1991) and most authors on learning and continuous improvement (MacDuffie 1997; Harrison 2004; and Jones and Mitchell 2006) cite the importance of information processing, though without attempting the synthesis with lean theory which we attempt.

2.2 Information processing theory

Our starting point is Lapsley's (2009) assertion that public services are characterised by complexity. For the NHS it's lean initiatives, from the viewpoint of information flows, complexity arises from uncertainties associated with an open system (public demand) served by an organisational design interconnecting intricate vertical and horizontal systems across spatially diverse points. In short, using Casti's (1994) formulation, NHS complexity results in a nonlinear system: there is no simple

relationship between inputs and outputs, indeed, without adequate information systems, the NHS as a system and sub-system levels, may not know its inputs and outputs or be able to identify bottlenecks.

Simon (1974) argues that the amount of information flowing if often greater than the ability of organisations to process it. Weick (1995) concludes that this makes the idea the *organisation* redundant; instead asserting that management's task is *organising* to reduce equivocality. Our view is closer to Argyris (1977): management can reduce uncertainty by flexibly responding to change. As Galbraith (1974) points out, uncertainty is the *difference between the amount of information required to perform the task and the amount of information already possessed by the organisation*. Information is data that is relevant, accurate, timely and concise filtered from unstructured or unsynthesised data (Beerel 1993). Thus, information processing is *the gathering, interpreting and synthesis of information in the context of organisational decision-making*.

Organisations may be designed using functional or information-led structures (Louadi 1998). Galbraith's (1974) view is that where organisations are not explicitly designed around information-flows, they default to functional design, resulting in sub-optimal performance. Information-led organising uses rules and programmes, hierarchies and goal setting to control and coordinate (Gell-Mann 1994). As coordination between sub-units and tasks becomes more complex, face-to-face decision-making is unfeasible and predefined rules provide the appropriate responses to events and tasks.

Information and organisations

How does information processing fair in a complex, functionally-structured and nonlinear organisation such as the NHS? As hierarchies grow and diversify, they tend to pull decision-making on exceptions from sub-units towards the centre, often slowing decision-making where decisions require rich and situated information/expertise in responses to uncertain and complex events (Carley 1995). Centripetal trends can be countered by centrifugal initiatives for example where a functional hierarchy sets broad parameters within which local decisions are taken, such as budgets and patient outcomes to push decision-taking back down to the points of exception. Beer's (1979) basic premise is that where goals diverge between leaders and sub-units, complexities will be dealt with differently at organisational or team level. The result, in Goldratt's (1993) terms, is no system flow. Sub-units privilege their own interests rather than those of the organisation: top management have only a limited ability to handle *diversity* and *oscillation* between units and central management. In predictable service systems, *calm* can be introduced by rule-making (Simon 1957) or rational decision-taking structures (Williamson 1985). However, in on-demand healthcare, as Stinchcombe's (1990) dictum seems apposite: coherent decision-taking requires real-time relevant information available to decision-takers.

The nature of such information, as Tushman and Nadler (1978) argue, is it *needs to be relevant, accurate, timely and concise* and *in the context of organisational decision-making.* Organisations are information processing systems facing uncertainty. Louadi's (1998) point that the amounts of information flow increase with environmental uncertainty and complexity is apt for healthcare. High levels of uncertainty, complexity and reduced buffers between tasks act to increase

interdependence (fragility) between tasks and subunits necessitating more information processing to coordinate optimal performance. Galbraith's (1974) information processing theory argues that organisations facing uncertainty need to *increase the ability to pre-plan, increase their flexibility to adapt to their inability to pre-plan or decrease the level of performance required*. Coordination occurs using vertical and lateral information systems with associated relationships and roles.

Vertical information systems (VIS) are ICT-enabled systems, which Akoki (1986) argues aim to acquire and distribute appropriate information to appropriate decision points in appropriate time. Appropriate here references decision frequency, scope of the data and scope of the decisions. VISs aim to integrate sub-tasks and support functions rather than create self-contained units; they are especially applicable to quantitative data with global scope and nested hierarchies (Campbell 1974). Lateral information systems, Stinchcombe (1990) argues, comprise of a spectrum of horizontal communications and joint decision-making processes, allowing problem resolution close to points of exception. Lateral relations are more useful when solving problems requiring qualitative and rich information placing emphasis upon control, coordination (i.e. flow) between subunits, avoiding self-contained (functionally organised) subunits (Weick 1979). Lateral relations can range from direct contact between functional managers through to formalised integrating and dual authority mechanisms such as matrix structures.

Seeking productivity gains, healthcare organisations have invested heavily in ICTs (Oliner and Sichel 2000;) though Lenz and Reichert (2006) question their efficacy, the absence of which Gera and Gu (2004) argues is the result of lack of training and restructuring. Whilst as Haux (2006) points out shifting from paper to digital repositories has enabled the gathering of a wider scope and amount of data, it is questionable whether the data fits Daft and Lengel's (1986) notion of information. In Neely's (2007) terms, NHS managers can be overloaded with data whilst information starved. Consolidation and integration of between IT systems into Hospital Information Systems, stretching across functional boundaries, potentially improves communication and coordination (Reichertz 1984). Tushman and Nadler (1977) argue that successful organisations with high task complexity and uncertainty need agile structures: organisational designs matching information processing with capabilities and devolved decisions, avoiding *equivocality.* In the NHS's uncertain and complex environment this requires rich information, group decision making, opinion seeking and question definition, along with developing a common grammar and judgement based on the exchange of information in subjective contexts (Daft and Lengel, 1986). Since lean initiatives are based upon value flows, they test the degree to which even elementary information is available in and between subunits. Our paper explores the impact of existing information systems on NHS lean initiatives.

2.3 Summary

Our research questions address the conundrum that whilst researchers such as Radnor and Walley (2008) argue that lean frameworks (including RIEs) are readily applicable in UK healthcare, it remains the case that many such projects fail. There may be many localised causes of failure (such as staff rejection, clinician disapproval), it may also be that generic factors cause widespread failure – it is this proposition that we explore.

In particular, we examine whether lean processes fail because of the absence of adequate information processing resulting from functional organisational design.

3 METHOD

Whilst Bolon (1998) has commented in general upon lean health projects, we are not aware of research seeking to synthesise lean theory and information processing theory with the project-level as the unit of analysis. This section lays out our methodological choices and the research methods we employ to address our two research questions: (1) Do the challenges of reintegrating lean project information with information systems contribute to project failure; and (2) How effectively do lean healthcare projects, (characterised by high instability, uncertainty and complexity), manage information processing? Our framework of analysis is information processing theory, which we integrate with lean thinking.

We needed to study the processes occurring in *live projects*, where respondents had current experience of change processes, knowing that this meant studying projects before their success or failure could be determined.

Our research is essentially qualitative since our interest is explaining how and why information processing affects lean project performance. We interpret information processing in lean healthcare projects delving deeply into internal project information processes and its relationship to hospital wide information systems seeking insights rather than statistical interpretations. Our analysis is an *interpretive inquiry* of a case study: social facts are not *out there*, they are socially constructed (Rabinow and Sullivan 1985) - interpreted and reinterpreted, what Rorty (1989:73) calls *knowing and doing in praxis* and Yanow (2000) *meaning making* referencing localised and contextual decision-making best narrated with reference to a situationally-specific social environment.

Validity derives not from the cumulation of *facts*, rather from analytical rigour (see Hawkesworth 1988) of well-chosen cases and context using an empathic perspective (Yanow 2003). Conclusions are contextually specific and require re-contextualisation if they are to generalise. Our aim is to bring conflicts and contradictions to the fore, and whilst gaining insights from the biases of the actors to co-produce with them an interpretation of change processes that makes sense. As Schwartz-Shea and Yanow (2003) point out, whilst appropriate positivist evidence-based decision-making may be appropriate for practice adaptation, in emergent and dynamic social fields critical research methods can be more revealing. Validity and trustworthiness in ethnographic research rests on honestly gathered data, honestly interpreted, respecting alternative interpretations (Angen 2000).

We begin by referencing research in a Scottish Health Board (SHB1) conducted during the last two years to justify our focus on information processing and our premise that some 50% of lean healthcare projects fail.

Our research design was to take a manageable number of projects (two) and delve deeply into their information processing involving detailed pre-understanding of the projects and their context and lengthy interviews with a cross-section of participants.

A second Scottish Health Board (SHB2) generously nominated two projects. A greater number of projects would reduce depth and comparison of projects and introduce unnecessary variables. Project 1 had been running for nine months using lean techniques, such as demand smoothing and value-stream mapping, to seek improvements in the 35 outpatient clinics at Hospital A. It addresses issues such as the booking systems, trained staff numbers, do-not-attends (DNAs) and specialist clinician availability. Project 2 is a crosscutting SHB2 project looking at ways to manage staff flexibility, linking with eighteen other lean projects and overall workforce planning. It had started twelve-months prior to our interviews, mostly conducting a value stream analysis. Its basic approach to assign all costs into a cost-cube (some 33% are currently unassigned) addressing perceived problems such as overspend on bank staff and absenteeism.

We began with telephone and email introductions and reading background papers and project reports supplied by the two Team Leaders after which we agreed an interview Schedule with the Deputy Chief Executive (sponsor of the projects), two Team Leaders and three project participants (one a member of both projects). These six sets of semi-structured interviews used a prepared questionnaire designed to elucidate issues of uncertainty and information flows. Following convention practice, (Kvale 1996) they were recorded and transcribed.

Our data is presented, (section four), as selected quotations from interviewees, having been encoded and patterns identified. The NHS and University of Edinburgh ethically approved our non-intrusive research. Analysis uses the conventions of qualitative research (Bryman and Bell 2007) principally, reflection and triangulation between data, general theory and our own sense-making (Miles and Hubermann 1984). Our theoretical conclusions are contextually situated around lean projects in UK healthcare, specifically the contingent relations between macro and micro systems and the agents populating them (see Llewelyn 2003). As such, the generalisability of our conclusions depends upon adopting practitioners' ability to recontextualise (Kinder 2002) sifting through any subjectivity inherent from the context and limited sample.

4 DATA

We begin with an overview of lean in the NHS aiming to convey its ubiquitousness by reporting on lean in a Scottish Health Board (SHB1) and then present data from interviews in SHB2, selected to illustrate issues associated with information processing in two lean projects.

4.1 SHB1 lean initiatives

The Nicholson challenge set out by its English CEO is to lower NHS spending by £20bn by 2014 a compound reduction of 6% per year, whilst protecting services, seeks to reverse National Audit Office estimates that productivity in hospitals fell by 2% per year during 2000 to 2008. SHB1 was an early adopter of lean in its 2006 policy statement *Better Health, Better Care* it launched a programme of lean projects now rolling out across the entire Board, supported by US consultants using rapid improvement events (RIEs). There are examples of successes and failures of lean initiatives in SHB1. For example, Breast Screening (a clinician-led demand-

smoothing project has now eliminated waiting lists and vastly reduced waste. A major hospital's A&E project (featuring triage, takt, touch and treat and multidisciplinary teams) began to unravel after its first year. Confidential data made available to the authors, (figure 1) was given to support a practitioner estimate that 50% of lean projects fail to deliver their cost-reduction targets.

	Output change	Input change	Productivity shift
Radiology	103	106	-2%
Endoscopy	133	129	+3%
Medicine for the elderly	100	108	-7%

Figure 1: performance of selected SHB1 lean projects (source: confidential)

All SHB1 lean projects are RIEs. Our informant suggests that George's (2003) estimate that only 50% of savings from six-sigma RIEs eventually crystallise rings true. We do not present this unsatisfactorily unsubstantiated viewpoint as hard evidence, though it aligns with out own experience. What we do suggest is that there is a case to be investigated which for us is not how many project fail, but why and how.

4.2 Scottish Health Board 2 (SHB2) Project Interviews

4.2a Information processing

Our data shows a consistent understanding of and differentiation between data and information, and of the importance in terms of relevance, accuracy and timeliness. All subjects acknowledged this as a starting point for engagement with clinical staff and as a baseline against which to measure improvement. One subject acknowledged the influence of high performing organisations and their use of data as a driver for improvement work.

> *the top performing healthcare setups all use data, not for judgement but for looking at improvements*.
> (Subject 5: lead, Primary care project [PCP])

4.2b Uncertainty

Uncertainty is associated with variance in demand and capacity with some subjects emphasising referral volumes and multiple pathways while others focussed on matching resource capacity to demand.

> *What we are showing is in a lot of services there is a huge variation in referral volumes every week so we are trying to actually manage that, it is quite difficult to manage the variations*.
> (Subject 4: participant in both projects)

Subject 4, in a second interview acknowledged that as patterns of demand were recorded, its predictability increased, a view echoed by subject 1.

> *Patient demand is fairly well known…the issue has been more the capacity, so we know what's coming into a service, but we need to make the service leaner*.
> (Subject 1: participant PCP)

4.2c Information Gathering

Each project gathered vast amounts of information e.g. costs, demand, capacities, activity levels and queuing with subjects emphasising the use of financial metrics. The hospital financial systems were a good source of information but most non-financial information was gathered manually owing to gaps between available and required information.

> *there was a lot interviews with staff and consultants and nurses and such things to find out what resources go into there where we didn't have readily available.*
> (Subject 1: participant PCP)

> *the approach to this has been absolutely manual...*
> (Subject 4: participant in both projects)

During project execution, the information needs grew, resulting in additional manual data collection interpretation. Gaps were identified between functional information systems and the information needed by the projects as well as a skills gap in data interpretation.

> *the systems that we have got don't match in with any patient activity and they are quite separate functions so when you are trying to do any improvement work...it tends to be you have to get two sets of data and try and match them manually*.
> (Subject 2: lead on organisation project [OP])

4.2d Evaluation

The subjects and projects were divided about measuring and evaluating process results. Two out of the three subjects from the workforce project highlighted the change in evaluation measures away from purely financial measures. Subjects from the outpatient project emphasised differences between productivity and clinical measures and the perspectives of the clinical staff.

> *we can provide lots of productivity information but it is not always what the clinicians want to see*.
> (Subject 5: lead, PCP)

There is no clear perspective on how evaluation is conducted, the Workforce project emphasising on-going evaluation and test of change against trajectories while the Outpatient project utilising benchmarking. The outpatient project has a strong sense of shaping the information and reporting requirements on what clinicians feel is relevant.

> *Using CHKS the responses we have had have been good, and they are working with us to get the information that they feel is useful to them in terms of helping to improve their services*.
> (Subject 5: lead, PCP)

There is a consistent approach to utilising information and reporting to evaluate performance in both projects although there are differences reported in how and why the information is reported.

4.2e Re-integration

Inconsistencies emerge about how improvements are re-integrated into service operations. Three different themes emerge, firstly, within the projects there is a shift in ownership and focus on managers taking ownership of improvement and reporting, secondly, building capacity to support this shift and thirdly, building new measures into existing reporting systems.

> *we get a lot of information requests through from service improvement teams and from particular projects so we build the metrics and the measures around these requests*.
> (Subject 4: participant in both projects)

4.2f Slack resources

There is tacit and explicit acknowledgement across subjects of slack resources and these are key drivers of both projects.

> *And therefore there was staff available within all of the outpatient services but there was no clinician to actually go over there to outpatient services*.
> (Subject 5: lead, Primary care project)

> *we do waste quite a bit in terms of supplementary payments, ad hoc payments bank and overtime*.
> (Subject 2: lead, OP)

4.2g Vertical Information Systems

A number of information systems are being developed or altered as a result of the projects. Three distinct types emerge, organisational reporting and performance measurement systems, management and control systems and also patient information systems. Across these types, subjects recognised the value of real-time information as well as the local scope of information currently available.

> *This is for real-time so we know it will be dirty data but it gives them information straight away*.
> (Subject 4: participant in both projects)

> *individuals have developed their own systems to compensate for the lack of corporate system, but most just default to that monthly, 6 monthly, annual cycles. I think it doesn't lend itself well to rapid decision making*.
> (Subject 3: sponsor of the OP)

> *some of them have local databases where a lot of the qualitative information is captured*.
> (Subject 5: lead, PCP)

The systems are intended to centralise, filter and automate information gathering and synthesis for more efficient information usage.

4.2h Lateral relationships

The projects have acted as integrating mechanisms that work cross functionally and commonly utilise RIE's to span functional groups. All of the subjects recognise the bridging actions and RIE's assist in building relationships (albeit informal) between groups that are typically silo'd.

> *At the moment, there is information within all of these areas but it will sit standalone, and there are information people within each of these areas that produce reports...until we can find a way to pull that all in together.*
> (Subject 4: participant in both projects)

Most subjects recognise that departmental relationships need to change indicating increasing awareness of the interdependence between functions.

> *I think there has been a recognition that relationships have needed to change between certain departments... it is quite informal at the moment, I think the formal structure will need to change across those departments*.
> (Subject 2: lead OP)

Thus a combination of two lateral relationships are seen, one the project mechanisms and also a functional bridge which is as yet informal and direct. Subjects also connected these spanning structures to the issue of changing culture and behaviour that is raised consistently as one of the challenges faced by both the projects.

4.2i Challenges

Both projects are information intensive and have experienced substantial and iterative periods of information gathering, analysis and cleansing.

> *The biggest challenges has been the timescale and sheer enormity of the information that is required and number of people that it's taken to feed into that process*.
> (Subject 1: participant PCP)

Subjects from both projects consistently stressed the data quality issues.

> *It's not the systems themselves, it is the quality of the data within the systems*.
> (Subject 6: participant, OP)

Subjects from the workforce project highlighted the lack of integration between systems and requirement for extensive data manipulation prior to integration.

> *they have all been developed to do different things and respond to different needs…There has not necessarily always been forethought given to the way that systems integrate, inter-relate into the reports*.
> (Subject 3: sponsor of OP)

More general challenges encountered include regulatory changes, stakeholder groups, functional silos and behavioural change.

> *Some of the challenges was working through politics, working through with our partnerships agencies*.
> (Subject 2: lead OP)

> *this cuts across some fairly traditional silos in terms of responsibilities and that's quite challenging for a lot of people*.
> (Subject 3: sponsor of OP)

5 ANALYSIS

Lean and all other change management projects are information-hungry. Our analysis argues that the information processing systems in which these projects operate and the decision hierarchy make their sustainable success difficult.

5.1 Lean?

Womack and Jones (2004) note that the first task of a lean project is to identify the value(s) that the system seeks to create. There is no evidence of goal congruency between management, project members and wider staff (still less external stakeholders) in these projects; indeed, clinicians dispute both productivity information and its significance for (healthcare) outcomes (4.2d above). Flow and customer-pull (i.e. downstream and upstream relations) whilst central to lean systems thinking hardly feature as tools in these projects, which remain self-contained. At best the projects are identifying obvious *waste* and seeking to persuade (uncommitted) staff to eliminate it. Project goals (cost-reductions) have been centrally set (section 3), in negotiation with benchmarking consultants by central management, rather than negotiated between staff, patients and other sub-units. In terms of devolved responsibility and information systems, neither project appears to have been *ready for innovation*; rather each is spending time gathering information some of which could have been available from central information systems. They also spend time seeking to legitimise their work with staff, other subunits and external stakeholders (GPs and patients), (4.2h). Both projects are constituted as RIEs i.e. using a narrow range of lean six-sigma tools (value stream mapping and statistical process controls [4.3d]), few resources (no dedicated leader, staff hours, little training [4.2c]) and a truncated timescale (4.2i). The latter point is critical. A lean project may spend eighteen

months stabilising and measuring and negotiating values and then proceed to spend another eighteen months making lean changes. In short, from examining the process the projects are using, it seems fair to conclude that both projects are *lean-lite* i.e. narrowly scoped (functional department not whole system), short-term and using a limited range of (RIE) tools. In particular, the projects highlight the low level of information flows available.

5.2 Lean healthcare and information processing

SHB2 and these projects operate amidst uncertainty, complexity and ambiguity: how effectively do they use information processing to reduce each of these challenges? This our first research question focuses on the internal working of the projects.

Whilst information processing is our focus, it is clear that other factors are influencing the projects. Indeed, the project (taskforce?) work legitimating the projects evidences a rejection of their *raison d'être* (4.2h). Our impression is that the projects are viewed by staff as a top-down imposition, *not lean but low cost* and perceived as antithetical to NSH culture and the values of professional healthcare staff. The example from SHB1's A&E department illustrates that without commitment-based human relations even successful lean projects unravel and fail to deliver continuous improvement: the internal and intra-organisational linkages lean requires presume a shared destiny – deep trust – otherwise their interdependency results in fragility.

After nine and twelve months the projects gathered vast amounts of information using (tools such as value stream mapping and cost and time measurement, 4.2c): they acknowledge, the importance of relevant, accurate and timely information for effectiveness (4.2d). For example, Project 1 now knows the capacity and cost of outpatient clinics. As Pyzdek (2001) predicts of lean-RIEs, they appear better able to identify waste than to act to eliminate it, which requires other subunit and stakeholder cooperation, hence they are unable to process gathered information into proposals achieving more from less.

Our research design decision to explore live projects provides data on current action but not final evaluation data (4.2d). Project two's success criteria are financial targets, whilst project one's goals are clinical performance, staff engagement and private sector benchmarks. Much of the cost/capacity information was gathered manually (4.2d), by staff continuing to perform ordinary duties, analysed and disseminated by them - additional work for which they were largely untrained (4.2c). Clinicians, who conceptually differentiate between productivity information and clinical performance, disputed their conclusions.

The projects gathered and analysed data manually, often elementary cost/capacity data, unavailable from central information systems the conclusions from which were disputed by a senior clinician.

5.3 Reintegrating information and project success

Our second research question is do the challenges of reintegrating lean project information with information systems contribute to project failure? This issue seems

better understood by central than project management (4.2g). Whilst operational staff now better understand demand from trend analysis; demand and capacity remain their greatest uncertainty and matching the two their high level problem. From this perspective, there are two internal areas of complexity (4.2e): aligning demand and capacity and introducing the flexibility needed to match the two within the HR and legal framework. There is also the external complexity (to the hospital) of gathering and integrating data from other functional groups and stakeholders such as GPs and patients; *in Galbraith's (1974) terms information processing and organisational structures are not aligned.* Although planned the new central information system remains at conceptual stage and the clinical dashboard is under development: there are no central systems capable of integrating the project information.

Both projects have developed new standard operating procedures as solutions to problems, yet other subunits and external stakeholders have yet to accept their roles as players in an integrated system by accepting and operationalising these proposed new *rules and policies*. Whilst central management framed goals and targets, largely on the basis of consultant's benchmarking information, neither subunit has accepted these goals and targets – the value being created remains the subject of dispute. SHB2's *strategy* of waste reduction whilst accepted as a driver by the projects continues to clash with the Board's functional structure which necessarily relies on over-capacity and sub-optimal performance: the projects are unable to resolve perceived problems with self-contained initiatives posing challenges for the hospital hierarchy since the VISs fail to provide elementary information such as cost of staffing in a unit or capacity. Two new VIS are planned as a SHB2 strategy to improve information processing capacity: (1) patient tracking and a redeployment register to match capacity to demand reducing costs and (2) a clinical dashboard including performance measurement). Real-time information is impossible without first revising the hierarchy's elongated planning and financial reporting cycles, which are often six-months (4.2i). Note also, that leanness presumes devolved power over resources: adequate information processing is creating challenges to the entire hierarchy.

Where projects interface with other service units, they require qualitative and quantitative information and judgement - rich *lateral information flows* (4.2h). Instead, the hierarchy has nominated a workforce liaison person in other units for project two and a Capacity Manager relating to project one's work.

Stinchcombe's (1990) point is that rational decision-taking structures and rules does not reduce uncertainty, rather it requires real-time relevant information and decision-taking at points of exception and delivery. The projects show that lean is driving increasing awareness of information processing (4.2e), misalignments remain between project information needs and central systems and inter-organisational gaps (for example around demand). Lean tools are effectively used by the projects to identify waste, however agreeing actions proves more difficult because of lack of buy-in by some participants, information insufficient to eradicate uncertainty and gaps between cross-functional teams. There is no evidence of Argyris's (1977) double-loop learning. Manually gathered data is not re-integration with central information processing. *Management are successfully framing issues and problems, without providing the tools necessary to resolve them*.

6 CONCLUSIONS

This research has explored the inter-relation between lean principles and information processing theory in the conduct of two lean projects in SHB2. Crucial to the systems perspective, the roots of both lean and information processing theory are joined-up and coordinated functions: flow. Closer coordination, characterised by shared information and lower buffers, uses information to create interdependency (and fragility). Matching of demand and capacity further eliminates waste. In short, performance improvement integrally links to information processing. As yet, the projects have not demonstrated a *causal* link between improved information processing and improved performance. Without robust demand-smoothing information, accepted by clinicians, justifying change to reduce waste is likely to be problematic, especially where controls and coordination between sub-units needs to alter (Galbraith 1974). The option of self-contained teams, whilst available to the car plant, has limited feasibility given the multiple specialisms in hospitals.

Our research challenges Radnor *et al's* (2006) conclusion that whole systems approaches to lean or lean-RIEs are an equally valid. Their conclusion may apply where information is narrow in scope and global, however, in healthcare where information is diverse, rich and contextual, lean-RIEs are shown as having difficulty faced with inadequate information processing, low senior clinician engagement and an absence of commitment-based human relations. Indeed, in the healthcare context, RIE's (see above) are short-term cost-cutting exercises, which as Caldwell *et al* (2005) suggests fail to crystallise long-term savings.

We support Fillingham's (2007) argument that lean healthcare is only achievable on a whole-system basis, as in Stanford, the site of George's (2003) study, for two reasons. Firstly, the absence of hospital-wide vertical and lateral information systems means that projects gather and analyse data manually and are unable to reintegrate it into wider information systems making stabilisation and continuous improvement difficult. Secondly, theory of constraints (Goldratt and Cox 1993) argues that simply making one unit more efficient shifts bottlenecks elsewhere in the system: time/money lost at any point in a flow system is time lost to the whole system.

Healthcare leaders seeking to adopt lean perspectives should first ensure that systems are stable and adopt Galbraith's (1974) choice of an information-led organising design to ensure (Tushman and Nadler 1978) that relevant and accurate information is available in real time – these are *ready for innovation* preconditions. This implies restructuring financial planning cycles, which, as Haux (2006) suggests, goes deeper than simply investing in ICT and instead eliminates replaces functional structures, with a flow system.

Causally linking strategy with performance in a flow system assumes a shared destiny between all stakeholders, including external stakeholders such as patients, GPs and political funders; without which, as Neely *et al* (2007) points out, disputes will remain over which value-creation the system is privileging. Such an approach requires a long-term stability in healthcare and governances systems capable of maturely aligning competing goals – part of the complexity to which Lapsley (2009) refers. Time to change and stability from which to change are essential not only to lean, but

to any change initiatives for an organisation facing complexity, uncertainty and ambiguity. More subtle approaches to change are required than simple linear transplantation of techniques from other sectors and cultures.

There are successful lean projects in Scotland - the breast screening example in section 4.1 was consultant-led, self-contained (though making referrals) and able to smooth patient demand. Success, however measured, in lean takes time and relies upon the commitment and engagement of staff (Williams 2002).

The transfer of technologies and techniques between the private and public sectors can benefit processes, however, it is important not to conflate processes with governances. In the UK healthcare since 1948 has not be marketised commodity for the majority of people, nor can patients simply be conflated with customers as Kenneth Arrow argued in 1963, *the special structural characteristics of the medical-care market are largely attempts to overcome the lack of optimality due to the non-marketability of the bearing of suitable risks and the imperfect marketability of information.* Lapsley's (2009) point on the complexity of healthcare, like Arrow, is that its management needs subtle touch. It is disturbing how underdeveloped current information systems are, especially since, as Louadi (1998) argues, inadequate systems are a brake on efficiency and effectiveness, (including patient access and equity). Faced with silo'd departments rather than system and flow, the dominant picture exposed by the lean projects is one of a functional hierarchy bearing the costs of self-contained units, without systemic flow.

The generalisability of our conclusions may be challenged, especially the suggestion that 50% of RIEs fail and the importance we are attaching to information processing. In all qualitative research, generalisation requires interrogation of target context for relevance: our conclusions are no different.

Further research on lean healthcare projects may reveal the relative importance of information processing in project processes compared with other issues such as the ideology of lean, difficulties enrolling stakeholders and the role of professionals.

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